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Maine Geological Survey

John R. Rand, State Geologist

GEOLOGY OF THE BECK POND AREA

Township 3 - Range 5

Somerset County, Maine

by

Arthur J. Boucot, Charles Harper, and Keith Rhea
Department of Geology and Geophysics
Massachusetts Institute of Technology
Cambridge, Massachusetts

Special Geologic Studies Series #1

Department of Economic Development

Augusta, Maine

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GEOLOGY OF THE BECK POND AREA

Township 3—Range 5, Somerset County, Maine

by
Arthur J. Boucot, Charles Harper, and Keith Rhea

Department of Geology and Geophysics
Massachusetts Institute of Technology
Cambridge, Massachusetts

Introduction

This report deals with a body of limestone and limestone conglomerate near King and Bartlett Lake in the Spencer quadrangle (fig. 1, 2). The purpose of the investigation was to obtain as much information as possible on the extent, geological relationships, and grade of the limestone, which had been found earlier by Hurley and Thompson.[1] The limestone and conglomerate are exposed on a low hill in the northwest corner of T. 3, R. 5. in the area west of Beck Pond and Bear Pond. Three days of study by Boucot in the course of a U. S. Geological Survey mapping project constitute the only previous geological investigation of the area.

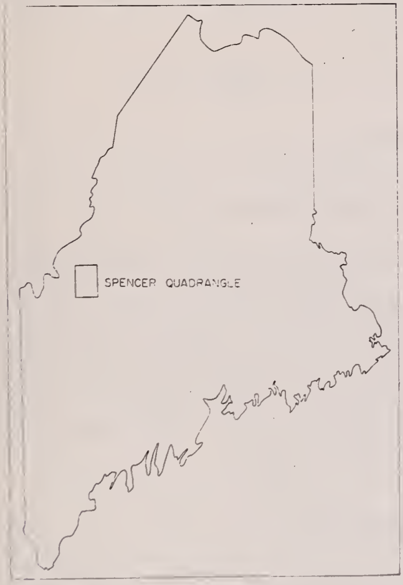

FIGURE 1—Index map for Spencer quadrangle, Maine

Mapping was done with a tape and compass. The geologic map was prepared by Harper and Rhea, using in part the stratigraphic units employed by Boucot in a report to be published by the U. S. Geological Survey. Paleontologic dating was done by Boucot, and the determinations of insolubles were made by Rhea.

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[1] Hurley, Patrick M., and Thompson, James B., Airborne magnetometer and geological reconnaissance survey in northwestern Maine. Geol. Soc. Am. Bull., 61 (8): 835-841, Aug. 1950.

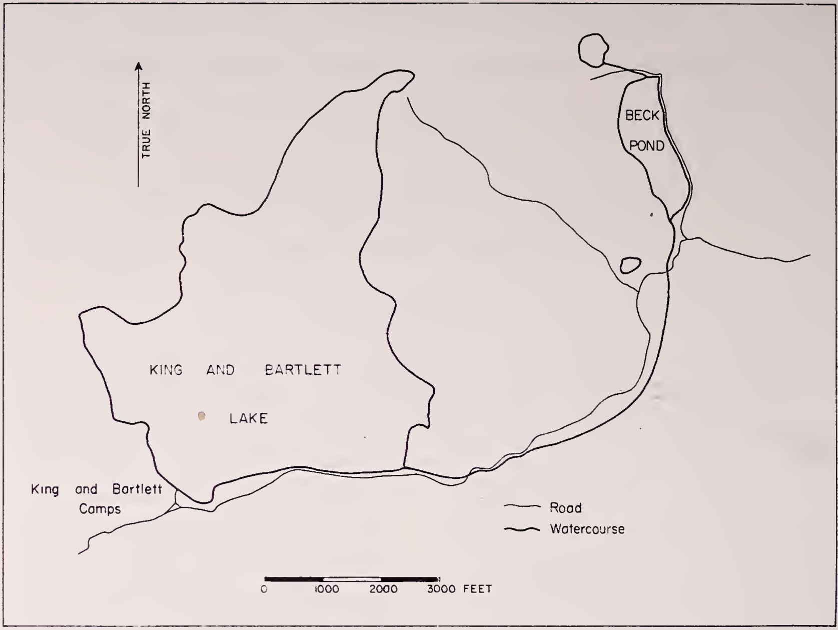

FIGURE 2—Index map showing location of the area

The authors acknowledge with pleasure the suggestions made by the following visitors in the field: John R. Rand, Maine State Geologist; Professor W. F. Brace, Massachusetts Institute of Technology; and Arden Albee, Andrew Griscom, Philip B. King, Robert B. Neuman, and Louis Pavlides, all of the U. S. Geological Survey. The work was supported by the Maine Geological Survey.

Stratigraphy

The northwest portion of the Beck Pond area is underlain by granitic basement complex of pre-Silurian age. Nonconformably on the basement complex lies the Beck Pond limestone and the Seboomook formation. The Beck Pond limestone, of New Scotland (low Lower Devonian) age, is subdivided into five units, Members 1 through 5. The Seboomook formation includes a main body of slate, the Bear Pond limestone member, and a basal granite talus member. The basal portion of the Seboomook formation is of New Scotland age, but its middle and upper portions to the southeast of the Beck Pond area are of Oriskany (high Lower

Devonian) age. The Bear Pond limestone member is of New Scotland age. Several exposures of dark-colored boulder conglomerate, of Silurian or Lower Devonian age, are present. Intrusive into the first three of the above units are several bodies of diabase. At one locality an isolated area of lime-silicate hornfels, in contact with the diabase, is lithologically and faunally similar to the Bear Pond limestone.

Lower Devonian

Seboomook formation

In this area the Seboomook formation consists of a main body of gray slate, the Bear Pond limestone member, and a granite talus member.

Main body of the Seboomook formation

LITHOLOGY.—Slate forms the main body of the Seboomook formation. Dark gray to black on fresh surfaces and light gray on weathered surfaces, it contains euhedral to anhedral crystals of pyrite up to 2 millimeters long. The pyrite forms about 2 percent of the slate and is found in small areas which are probably near the slate-diabase contact. Where the pyrite is present, the slate weathers light buff and is distinctly pitted where irregular areas of pyrite have weathered out. Many of the pits contain reddish-brown limonite.

THICKNESS.—The upper part of the Seboomook formation has been eroded away in the area studied, and the thickness of the unit was not measured.

LOWER CONTACT.—From outcrop 36 northward the main body of the Seboomook conformably overlies the granite talus member. This contact may be seen at outcrops 36, 39, 40, and 41 (northern end). Between outcrops 31 and 36 and to the south the main body overlies the Beck Pond limestone with angular unconformity, the contact being exposed at outcrops 10, 11, 12, 16, 19, and 20.

AGE.—In the Beck Pond area the lower part of the main body of the Seboomook is of New Scotland (low Lower Devonian) age. It contains *Atrypina* sp. at outcrop 16, and *Orthostrophia* cf. *O. strophomenoides* and *Levenea* cf. *L. subcarinata* in the basal few inches at outcrop 12.

Bear Pond limestone member

LITHOLOGY.—The limestone is blue-gray on fresh surfaces and gray on weathered surfaces. It contains subrounded to sub-angular granite pebbles up to 2 inches across; fragments of brachiopods, corals, and crinoid stems; angular black calcite crystals or fragments up to coarse sand-size; brown and white mica flakes up to 1 millimeter in diameter; and some pyrite or other iron-sulfide crystals less than 0.5 millimeters across. Silt-size material is abundant. The approximate percentage composition is 40 percent quartz, 30 to 40 percent fossil fragments and calcite grains, less than 5 percent granite pebbles, less than 1 percent mica, and less than 1 percent pyrite, with the remainder of silt-size material.

The granite pebbles are medium-grained phaneritic, with subhedral crystals of quartz, biotite, and possibly a sodic or potassic feldspar. The quartz contains many small inclusions up to 0.5 millimeter across of a dark brown mineral. The biotite occurs in crystal aggregates up to 2 millimeters across. Approximate composition of the pebbles is 50 to 60 percent quartz, 30 to 40 percent feldspar (orthoclase?), and 5 percent biotite.

THICKNESS AND CONTACTS.—The Bear Pond limestone member was observed only at one outcrop where it is situated 10 feet stratigraphically above a slate exposure. Neither the top nor the bottom of the unit was exposed, and the nature of the contacts is unknown. The thickness is about 10 feet.

AGE.—The Bear Pond limestone contains a brachiopod fauna generically similar to that in Member 5 of the Beck Pond limestone, which is characterized by *Eospirifer macropleura* and *Orthostrophia strophomenoides*. Both faunas are of New Scotland (low Lower Devonian) age. The Bear Pond fauna contains a large number of specimens of *Leptaena "rhomboidalis"* and *Kozlowskiellina* sp., unlike Member 5 but like the lime-silicate hornfels.

Granite talus member

Below the slate of the Seboomook in a strip northwest of Beck Pond is a sequence grading from massive granitic basement complex up into granite talus. Where it is present, the talus forms the base of the Seboomook formation. The contact between the basement complex and the talus is a nonconformity striking N.-S. and dipping about 45° E.

Jointed massive granite, grading up from the basement complex granite, forms the base of the talus. The joints become increasingly wider higher in the unit, and at the top the unit consists of angular to sub-angular pebbles, cobbles, and boulders of granite up to 5 feet across, cemented by sandy material composed primarily of quartz grains or by slate of the Seboomook. The sandy material and the slate also fill the joints. Quartz grains in the sandy material are sub-angular to angular and coarse sand-size or smaller. Some fine-grained material is also present.

The talus is about 20 feet thick. It is present at outcrops 36, 39, and 40, in the northern 100 feet of outcrop 41, and at the outcrops between the northern part of outcrop 41 and the southern part of outcrop 39.

Beck Pond limestone

The Beck Pond limestone has its type area and only known occurrence on the south part of the hill. It is subdivided into 5 members.

Member 1, the oldest unit, is predominantly coarse, gray-green, quartzose limestone containing one or two stromatoporoid biostromes. Some of the sandy layers are well cross-bedded. Member 2 consists chiefly of stromatoporoid biostromes interlayered with minor amounts of gray-green, quartz-rich limestone containing some coral and stromatoporoid fragments. Member 3 is similar to Member 1 and also has distinct bedding and cross-bedding. Member 4 is light-colored granite-boulder conglomerate containing boulders up to 15 feet across. The boulders have the same lithology as the basement complex granite, and the matrix is gray-green and highly calcareous. Member 4 is much more coarse-grained and less well-sorted than any of the other units. Member 5, the uppermost unit, is coarse-grained, gray-green, calcareous quartz conglomerate similar to Member 4 but containing more fossils, which are concentrated in certain layers. With a few exceptions, the granitic fragments in Member 5 range up to cobble size, rather than to boulder size as in Member 4. This unit is for the most part coarser-grained and more fossiliferous than Members 1 and 3 and has generally indistinct bedding.

Light-colored granitic basement complex underlies the formation and occupies a large part of the northern end of the area mapped. Granite pebbles, cobbles, and boulders, presumably derived from the basement complex, are found throughout the Beck Pond limestone.

THICKNESS.—The Beck Pond limestone is about 750 feet thick.

AGE.—The Beck Pond limestone contains several brachiopod faunas of New Scotland (low Lower Devonian) age. At outcrop 10 Member 5 has yielded a fauna characterized by *Eospirifer macropleura, Levenea subcarinata, Orthostrophia strophomenoides*, and *"Camarotoechia" alveata.* The Member 5 fauna is so similar to that found in the New Scotland formation of eastern New York that the correlation of the two appears to be as well founded as such correlations can be. At outcrop 22 Member 1 has yielded a limited brachiopod fauna characterized by a species of *Nanothyris* similar to those occurring elsewhere in strata of post-Manlius-Coeymans age. Numerous specimens of *Kozlowskiellina* sp. are also present. From its stratigraphic position beneath Member 5, it is concluded that the Member 1 fauna is also of New Scotland age, although it is very restricted in number of genera.

Member 5

LITHOLOGY.—The rock is light gray to greenish-gray conglomerate with granite pebbles and cobbles, stromatoporoid fragments, tabulate coral fragments, crinoid columnals, and some horn corals and brachiopods, in a quartzose, sandy limestone matrix. The matrix is chiefly sub-angular to angular, fine to coarse sand-size grains of quartz and calcite. The crinoid columnals, from 2 to 10 millimeters in diameter, are locally abundant and form as much as 5 percent of the rock. The relative proportions of quartz, calcite, and crinoid columnals vary considerably from bed to bed. Bedding is indistinct.

Outcrop 10: Many small angular to sub-rounded granite pebbles and cobbles are present, the pebbles being more abundant. At the base of the section (toward the north end of the outcrop) the pebbles are more numerous, and the rock is more quartzose. Organic constituents include tabular and sub-rounded stromatoporoid fragments 1 by 1 inch to 6 by 2 inches in cross-section, many sub-rounded to sub-angular tabulate coral fragments up to 7 by 10 inches in cross-section, horn corals half an inch to 1 inch in diameter, and a few brachiopods. The corals do not have any preferred orientation, and the coral and stromatoporoid fragments are more abundant at the south end of the outcrop.

Outcrop 9: Only a few well-rounded granite pebbles are present. Organic debris includes sub-angular to sub-rounded tabulate coral fragments commonly 4 by 4 inches but as large as 7½ by 13 inches in cross-section, and some sub-angular to rounded pebble-size stromatoporoid fragments. Interbedded with the limestone conglomerate are many small, irregular layers of non-limy, greenish-gray siltstone.

Outcrop 8: The granite pebbles are larger than at outcrop 9, the largest being 2½ by 1 inch in cross-section. The pebbles are sub-angular to sub-rounded and constitute less than 5 percent of the rock. Some sub-angular tabulate coral fragments up to 6 by 6 inches were found.

Outcrop 7: The granite pebbles are sub-angular to sub-rounded and as large as 4 by 4 inches in cross-section. Organic constituents include sub-rounded tabulate and stromatoporoid fragments up to 4 by 4 inches in cross-section, a few horn corals about one centimeter in diameter, and some brachiopods.

Outcrop 3: The rock here consists primarily of sandy limestone, which is locally crinoidal. One granite cobble 6 by 5 inches in cross-section and a boulder about 2 feet by 1 foot in cross-section are present. The matrix also contains a few sub-angular granite pebbles and a few rounded stromatoporoid fragments up to 3 by 3 inches in cross-section.

THICKNESS AND LOWER CONTACT.—Member 5 is about 75 feet thick.[1] The lower contact with Member 4 was not observed.

Member 4

LITHOLOGY.—The rock is a conglomerate with pebbles, cobbles, and boulders of granite, pebbles and cobbles of stromatoporoids, crinoid columnals, and a few tabulate coral fragments, all in a gray to greenish-gray, quartzose, sandy limestone matrix (fig. 3). The granite fragments are light-colored and consist of subhedral to anhedral crystals of quartz, anhedral crystals of feldspar, and a small amount of fine-grained phaneritic, anhedral crystals of black ferromagnesian minerals or brown mica. The feldspar in the granite fragments weathers chalky white to a depth of about three-quarters of an inch. The matrix consists of sub-angular to angular quartz sand grains in fine to coarse sand-sizes and angular to sub-angular calcite grains in fine to very coarse sand-sizes. The relative abundance of quartz and calcite varies from bed to bed. Bedding is indistinct.

Outcrop 1: The conglomerate here includes 2 sub-rounded granite boulders 6 to 7 feet in diameter and many smaller pebbles, cobbles, and boulders of granite. Many of the smaller fragments are very well-rounded to sub-rounded, but a few are angular. Organic constituents include well-rounded to sub-angular stromatoporoid fragments, a few small tabulate coral fragments, and a few horn corals less than 1 inch in diameter.

Outcrop 2: The rock on the east end of the outcrop is very sandy. Bedding is horizontal, and cross-bedding indicates that tops are up. Several 1- to 2-inch beds of sandy limestone conglomerate contain isolated sub-rounded to rounded stromatoporoid pebbles and cobbles and sub-rounded to rounded granite pebbles. A few of the granite pebbles

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[1] This and the following thicknesses were estimated assuming an average dip of 30° S.E. for the 5 members.

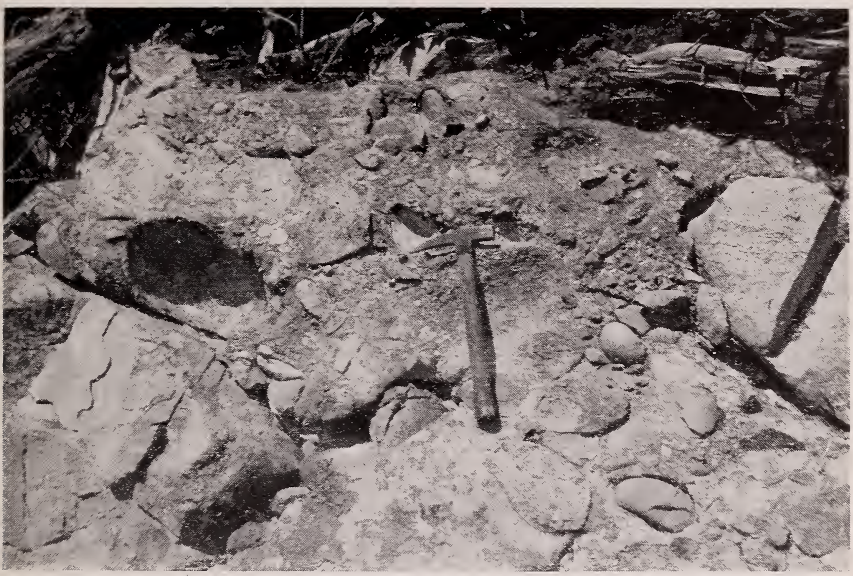

FIGURE 3—Typical granite-boulder conglomerate of Member 4

are sub-angular. The more tabular granite and stromatoporoid pebbles are aligned roughly parallel to the bedding, and the number of granite pebbles increases higher in the section. Two 2-inch limy beds containing about 5 to 10 percent quartz grains are also present.

The above beds are stratigraphically about 4 feet thick. Directly overlying them is a layer of sub-angular stromatoporoid pebbles and sub-angular to sub-rounded granite pebbles up to 3 inches across, in a sandy limestone matrix. Overlying this layer, a sub-angular granite boulder about 5½ by 2 feet in cross-section is embedded in a sandy limestone matrix.

In the middle of the outcrop the conglomerate consists of sub-angular to sub-rounded pebbles, cobbles, and boulders of granite up to 14 inches across, sub-angular stromatoporoid fragments up to 2 by 4 inches, and sub-rounded to rounded tabulate coral fragments 1 to 2 inches across, in a sandy limestone matrix. A few horn corals about three-quarters of an inch across, disarticulated brachiopods, and one 2-inch long gastropod were also found. Bedding is indistinct. The strata are sandy, and in the highest part of the outcrop they contain more pebbles, cobbles, and boulders of granite up to 14 inches across. The pebbles, cobbles, and boulders are randomly distributed throughout the lower part of the outcrop.

Toward the west end of the outcrop the conglomerate is coarser. Granite boulders up to 3 by 1½ feet in cross-section and stromatoporoid fragments up to 8 by 10 inches in cross-section are found, as are rounded tabulate fragments 1 to 2 inches across. Still farther toward the west end of the outcrop the granite boulders are larger (up to 4 to 5 feet across), and there are many large stromatoporoid fragments (up to about 2 by 8 inches in cross-section) in the sandy, quartzose limestone matrix.

Outcrop 11: Here the granite boulders range from 6 inches to 6 or 8 feet across and are rounded to sub-angular. Sub-rounded to sub-angular granite pebbles and cobbles are also present. Organic constituents include sub-angular stromatoporoid fragments 2 to 4 inches across and a few corals and brachiopods.

Outcrop 12: Slate of the overlying Seboomook formation protrudes unconformably down into the limestone conglomerate of Member 4. The limestone conglomerate is exposed only in the western part of the outcrop, where it lies between and partly buries two granite boulders at least 12 to 15 feet across and perhaps larger. The two large boulders are less than a foot apart. The limestone conglomerate contains several smaller sub-angular granite pebbles as well as sub-rounded stromatoporoid fragments 1 to 4 inches across.

Outcrop 13: Angular to sub-angular granite boulders up to 4 feet across, a few sub-angular to rounded granite fragments, and sub-rounded stromatoporoid fragments a few inches in diameter are present in a sandy limestone matrix.

Outcrop 14: Sub-rounded to sub-angular pebbles, cobbles, and boulders of granite up to 6 feet across and sub-angular stromatoporoid fragments up to 3 or 4 inches across are present in a sandy, quartzose limestone matrix.

Outcrop 15: At this outcrop a sub-angular granite boulder about 7 feet across is surrounded by slate of the Seboomook formation. A few feet east of the boulder there is limestone conglomerate with small sub-rounded pebbles of granite up to 3 inches across in a sandy limestone matrix. In places the pebbles protrude a few millimeters into the slate.

Outcrop 16: The sandy limestone matrix contains a few sub-rounded to sub-angular granite boulders about 1 to 2 feet across, a few sub-angular to rounded stromatoporoid fragments, and some rounded tabulate coral fragments about 2 or 3 inches across. Cross-bedding shows that the beds are right side up.

THICKNESS AND LOWER CONTACT.—The contact of Member 4 with Member 3 is not exposed. On the map the contact has been placed 200 feet below the lowest known exposure of Member 4 and 300 feet above the highest known exposure of Member 3. Using the location of the lower contact as mapped, the thickness of Member 4 is about 200 feet, but it could be as little as 150 feet or as much as 300 feet.

Member 3

LITHOLOGY.—The member consists of gray quartzose sandy limestone conglomerate, gray quartzose sandy limestone, and calcareous sandstone, all with about the same mineralogy. Quartz grains are predominantly angular to sub-angular and of coarse sand-size or smaller. The fine material consists of sub-angular to sub-rounded calcite grains of fine sand-size or smaller. The coarse material includes sub-rounded to rounded stromatoporoid and other fossil fragments, and granite cobbles and pebbles. The largest fragments and cobbles are no more than a foot across, and most are much smaller. The percentage of insoluble material in the member is estimated to be at least 50 percent and may well be much higher. The upper half to three-quarters of the member was not seen, and it is possible that it becomes coarser higher in the section, grading into Member 4.

Outcrop 22: At this locality Member 3 overlies Member 2. Here Member 3 is sandy, quartzose limestone conglomerate containing angular to sub-angular quartz grains up to 3 or 4 millimeters in diameter, sub-angular to sub-rounded calcite grains in sand- and silt-sizes, and sub-rounded to rounded pebbles and cobbles of stromatoporoid fragments up to a foot across. Lower in Member 3, the stromatoporoid fragments are somewhat larger, possibly as much as 1½ feet across. Still lower, the limestone conglomerate of Member 3 grades into a biostrome of Member 2. Near the contact there are a few well-rounded granite pebbles up to an inch across and small, irregular quartz sand lenses (crevice fillings?) about ½ to 1½ inches thick. The sand is more abundant in some layers of the conglomerate than in others, and the sandy layers are distinctly bedded and contain some cross-bedding.

Outcrop 17: The sandy, quartzose limestone here contains angular to sub-angular quartz grains up to 3 to 4 millimeters across. Bedding is distinct, and the limestone is weathered to a loose brown sand to a depth of about 1 inch.

Outcrop 18: Here the sandy, quartzose limestone conglomerate of Member 3 is in contact with the pure stromatoporoidal limestone of Member 2. The contact is very well defined and slightly irregular. The conglomerate of Member 3 contains sub-angular to angular sand-size quartz grains, sub-angular to sub-rounded sand-size limestone fragments, and a few sub-angular stromatoporoid fragments ½ to 1 inch across. In places the sandy layers have been deeply weathered (up to 2 inches) to a loose brown sand. The sand is finer grained higher in Member 3 above the contact, maximum grain size being about 4 millimeters. Bedding is distinct in the sandy layers.

Outcrop 20: The southern 8 feet are sandy, quartzose conglomeratic limestone containing a few pebbles of limestone and granite about an inch across. The quartz grains in the matrix are coarse sand-size or smaller, and angular to sub-angular. Bedding and cross-bedding are well developed. The northern 12 feet of the outcrop are limestone conglomerate of sub-angular stromatoporoid fragments 1 to 6 inches across, sub-rounded granite pebbles, and a few crinoid columnals, in a matrix of sand-size sub-angular to sub-rounded fragments of quartz and calcite.

Outcrop 10: Sub-angular granite pebbles and cobbles up to 3 by 8 inches in cross-section are present in a matrix of calcareous sandstone containing coarse-grained, angular quartz.

THICKNESS AND LOWER CONTACT.—The lower contact with Member 2 is both sharp (outcrop 18) and gradational (outcrop 22). Using the location of the upper contact as mapped, the thickness of Member 3 is about 175 feet, but it could be as little as 50 feet or as much as 250 feet.

Member 2

LITHOLOGY.—Interbedded light-gray stromatoporoid biostromes and sandy, quartzose limestone are present in Member 2. The biostromes apparently represent the living environment of the contained stromatoporoids and form locally extensive beds or layers of almost pure calcium carbonate. The sandier, quartzose facies is sometimes found as crevice fillings at and near the irregular tops of some of the biostromes.

The sandy, quartzose limestone is chiefly sub-angular to angular quartz grains of coarse sand-size or smaller in a gray limestone matrix. A few small, well-rounded granite pebbles up to an inch in diameter are also present. The sandy, quartzose limestone immediately overlying some of the biostromes contains a few sub-rounded to rounded tabular stromatoporoid fragments and other fossil fragments.

Outcrop 22: Sandy, quartzose limestone occurs in beds a few centimeters to several tens of feet thick. A few well-rounded granite pebbles up to 1 inch across are present near the top and bottom of the member. Interbedded with the clastic beds are about 10 biostromes. Each biostrome rests on a layer of sandy, quartzose limestone containing stromatoporoid fragments, tabulate corals, brachiopods, and crinoid columnals. Crevices in the upper surfaces of the biostromes are filled with the same limestone. The average thickness of the biostromes is 10 to 15 feet, but some are as little as 3 and others as much as 30 feet thick. Near the top and bottom of the member the biostromes are thinner and the limestone layers thicker.

Outcrop 18: At the northern end of outcrop 18 and at the small outcrops directly west of the northern end of outcrop 18 pure limestone consisting of 2 stromatoporoid biostromes contains a few thin, irregular, sandy, quartzose lenses up to 6 inches thick. The bottoms of the biostromes are not exposed.

Outcrop 23-27: Pure limestone composed of stromatoporoid biostromes alternates with thinner beds of sandy, quartzose limestone containing sub-angular to angular quartz grains and stromatoporoid pebbles and cobbles. One biostrome at outcrop 27 is at least 30 feet thick, but the average thickness of the biostromes in these outcrops is about 5 feet.

THICKNESS AND LOWER CONTACT.—The contact between the pure limestone of Member 2 and the sandy, quartzose limestone of Member 1 is transitional, the sandy layers becoming thicker and the biostromes thinner near the lower part of Member 2. At outcrops 22, 23, and 24 the boundary between the two units was placed arbitrarily at the base of the lowermost biostrome. East of outcrops 23 through 27 the biostromes seem to form a ridge, and therefore just to the east of the diabase the contact was assumed to be associated with the small ridge there.

The member is estimated to be about 100 feet thick.

Member 1

LITHOLOGY.—The member consists of sandy, gray-green limestone containing sub-angular to angular quartz grains in fine to coarse sand-sizes, sub-angular to sub-rounded calcite grains in fine to coarse sand-sizes, granite pebbles, and stromatoporoid fragments. A few small stromatoporoidal biostromes are also present.

Outcrop 34: The limestone contains sub-rounded granite and stromatoporoid fragments about 1 inch across and weathers to a brown residual sand. The quartz grains are angular and coarse sand-size.

Outcrop 33: Sandy, quartzose, cross-bedded limestone overlies a stromatoporoid biostrome that is about 7 feet thick.

Outcrop 28: Some of the sandy, quartzose limestone layers contain sub-angular to sub-rounded stromatoporoid pebbles, cobbles, and boulders (up to 2 feet across), and a few well-rounded granite pebbles (up to half an inch across). The quartz is in fine to coarse sand-sizes, and the grains are sub-angular. A few horn corals, tetracorals, and crinoid columnals are also present. Sandy layers are cross-bedded.

Outcrop 30: The cross-bedded, sandy, quartzose limestone at this outcrop weathers to a brown residual sand. A few stromatoporoid pebbles are present.

Outcrop 22: The rock is sandy and quartzose. It contains sub-angular to sub-rounded pebbles of coral, stromatoporoids, and some brachiopods, as well as a few small, well-rounded granite pebbles less than 5 millimeters across.

Outcrop 32: The sandy limestone contains pebble-size fragments of stromatoporoids and corals. Quartz grains in the limestone are less than a millimeter across, and in the southern part of the outcrop the limestone is more calcareous than that at outcrop 22. Two or three biostromes less than 10 feet thick are also present.

THICKNESS AND LOWER CONTACT.—The contact between the Beck Pond limestone and the granite of the basement complex is not exposed. On the east side of the hill a body of diabase intrudes both the Beck Pond and the granite. The presence of many pebbles and boulders of basement complex granite in the Beck Pond formation indicates that their contact is a nonconformity.

Member 1 is estimated to be about 200 feet thick.

Dark-colored boulder conglomerate

A sharpstone boulder conglomerate is present at two outcrops. It contains dark-colored granitic fragments ranging from small pebbles to boulders 3 or 4 feet across, all in a sandy and slightly limy matrix. The pebbles, cobbles, and boulders are almost all angular. Lithologically, the granite in the dark-colored boulder conglomerate resembles that in the basement complex to the west of the map area; it does not resemble the granite pebbles in the Beck Pond limestone.

The matrix consists of angular sand grains (chiefly quartz) and rock fragments ranging from silt-sizes to coarse sand-sizes and apparently of the same granitic rock as the larger fragments.

The pebbles, cobbles, and boulders are merocrystalline, medium- to fine-grained phaneritic granite of hypidiomorphic-granular texture. The minerals contained include dirty-green feldspar (50 to 60%), dark minerals (20 to 30%), and quartz (about 20%). Fresh surfaces are dirty greenish-gray, weathered surfaces brownish-buff. The feldspar (calcic plagioclase?) weathers to a light gray to white chalky material. The dark minerals weather to brown to reddish-brown limonite.

Differential weathering has caused the larger cobbles and boulders to stand out in as much as 3 or 4 inches of relief on weathered surfaces. The matrix and larger fragments weather very light gray or white, reddish-brown, brown, or tan.

The dark-colored boulder conglomerate is exposed only at outcrops 5 and 6. It is bounded on the north by Member 5 of the Beck Pond limestone, but its extent to the south across strike and its extent along the strike of the Beck Pond limestone could not be determined. The top of the conglomerate (outcrop 5) is about 5 feet below Member 5 of the Beck Pond limestone (outcrop 4), but the relationship between the conglomerate and the Beck Pond limestone is not clear as the contact is not exposed.

The relatively fresh condition of the dark-colored boulder conglomerate aligns it with the associated strata of Siluro-Devonian age rather than with the pre-Silurian rocks of the basement complex or with the highly sheared, cleaved, and phyllitic Cambro-Ordovician rocks of the region.

Basement complex granite

Light-colored granite underlies the Beck Pond formation nonconformably. It is merocrystalline to holocrystalline, medium-grained phaneritic, and contains euhedral to subhedral crystals of a dirty-green, altered, calcic plagioclase and subhedral crystals of quartz. The rock is hypidiomorphic-granular, and the three principal mineral constituents are quartz (about 40 to 50%), feldspar (about 50 to 60%), and biotite (about 5%). Fresh surfaces are dirty green and slightly grayish, weathered surfaces light buff to brown. The feldspar weathers chalky white, and in some places weathering has penetrated as much as 10 millimeters.

Intrusive rocks

Diabase

Diabase is the youngest rock in the area. It intrudes the basement complex granite, the Beck Pond limestone, the lime-silicate hornfels, and the slate of the Seboomook formation, and its contacts with all four are typically fine-grained phaneritic to aphanitic.

The disbase-granite contact is visible about 300 feet north of the south end of outcrop 41. No alteration of either granite or diabase was observed.

Diabase intrudes the Beck Pond limestone in the small outcrop about 40 feet northeast of outcrop 18. Here the diabase is fine-grained phaneritic within 2 or 3 inches of the contact and contains some small calcite crystals up to 2 millimeters across. The limestone is also altered near the contact, containing some pyrite crystals (less than 3%) and having the same general appearance as the lime-silicate hornfels, although no prehnite was observed.

The contact with the slate is exposed at outcrop 37, where it is horizontal. No alteration of the slate was observed, but again the diabase is fine-grained phaneritic within 2 or 3 inches of the contact.

The diabase is merocrystalline and medium-grained phaneritic. It contains greenish-gray feldspar (about 60 to 70%), black amphibole (about 20 to 30%), pyrite (5 to 10%), and possibly some biotite (up to 5%). The crystals are mostly subhedral, but some of the feldspar crystals are euhedral. Fresh surfaces are very dark to black, weathered surfaces light gray. The feldspar weathers chalky white, and weathering is about 2 millimeters deep.

AGE.—The greenish-gray, altered plagioclase phenocrysts in the diabase indicate that it was intruded prior to the Acadian orogeny of Middle Devonian time, which probably effected the alteration of the feldspars. The youngest rocks intruded by the diabase are of New Scotland (low Lower Devonian) age.

Lime-silicate hornfels

One small body of lime-silicate hornfels was found at outcrop 45. On its eastern side the hornfels is in contact with the diabase, on two other sides the diabase is within 40 feet, and on the fourth side within 400 feet. The contact between the hornfels and the diabase is perhaps as much as a centimeter wide and is indistinct. The diabase is not noticeably finer-grained at the contact.

The hornfels is a gray-green crystalline rock containing many sub-angular to angular quartz grains up to coarse sand-size. Alteration has partly recrystallized the originally limy minerals; the quartz grains are in a milky-green matrix, and many small veinlets of black prehnite up to 1 centimeter thick are present. Contacts between the prehnite and the gray-green hornfels are about 0.2 millimeter wide.

The hornfels weathers light to dark buff, and the prehnite-hornfels contacts show pronounced reddish-brown iron staining where they are in the weathered zone. The rock contains 70 to 80 percent quartz, 5 to 10 percent greenish feldspar (originally calcic plagioclase), 5 to 10 percent calcium carbonate (including fossil fragments), and up to 2 percent pyrite. The pyrite seems to be concentrated near the diabase-hornfels contact, and in small local concentrations the pyrite content may be as high as 10 percent. The prehnite content may be as high as 5 to 10 percent. The prehnite was identified by its powder pattern and optical properties.

AGE.—The abundance of *Leptaena "rhomboidalis"* and *Kozlowskiellina* sp. in the lime-silicate hornfels is reminiscent of the nearby Bear Pond limestone of New Scotland age, with which the hornfels is correlated.

Structure

Basement complex granite occupies a large part of the area. On the west side of the hill the contact between the granite and the Beck Pond limestone is not exposed, and on the east side a younger body of diabase intervenes. The presence of pebbles, cobbles, and boulders of the granite in the Beck Pond limestone indicates that the contact is a nonconformity. The location of the contact on the map was approximated from the location of scattered outcrops of the two units. The nonconformable contact between the basement complex granite and the basal granite talus member of the Seboomook formation has a strike of about N.-S.

To the east the granite talus member is overlain by the main body of the Seboomook formation. A ridge formed by the granite talus extends from the northern part of outcrop 41 to about 150 feet north of outcrop 40. The contact is exposed at four outcrops, and at all four it is irregular in form. This irregularity results partly from the presence at the contacts of massive jointed granite and angular to subangular pebbles, cobbles, and boulders of granite up to several feet across.

At outcrop 36 the basement complex granite apparently occurs as an inlier. The contact between the granite and the slate of the Seboomook is exposed at outcrop 36, and 150 feet west of outcrop 36 the contact between the granite talus member and the slate of the Seboomook is exposed on the granite talus ridge, where the general strike of the contact is N.-S. The presence of the slate contact at both outcrops cannot be explained topographically, as outcrop 36 is only about 10 or 15 feet lower than the contact on the ridge.

The strata of the Beck Pond limestone in general strike between N. 50° E. and E.-W. and dip 25° to 45° S. Two notable exceptions, however, are at outcrop 2, where the beds are flat-lying, and at outcrop 16, where they strike N. 10° - 30° E. and dip about 45° W. Original dip can be used to explain these apparent anomalies. Bedding is obscure in some places and reasonably well defined in others. The more sandy layers commonly have better-developed bedding than the less sandy layers, and in many places the more sandy layers are cross-bedded. In Members 1 and 3 bedding is well developed because of the distinct variations in grain size in the many sandy limestone layers. Member 2 contains many distinct stromatoporoid biostromes, but their irregular surfaces make the orientation of the bedding difficult to determine. In Members 4 and 5 bedding is indefinite because of poor sorting, lack of distinct variation in grain size within exposures, and lack of any evident orientation of the grains.

The contact between Member 1 and Member 2 of the Beck Pond is transitional. The contact between Member 2 and Member 3 is exposed at outcrops 18 and 22; in both places relatively pure stromatoporoid biostromes are overlain conformably by cross-bedded sandy limestone with stromatoporoid fragments near the contact. The contact between Member 3 and Member 4 is not exposed, and there are no outcrops between the lower part of Member 3 and the upper part of Member 4. The contact between Member 4 and Member 5 is not exposed.

The contact between Member 5 and the dark-colored boulder conglomerate is covered. The relation of this conglomerate to the other units in the area is unknown.

The Beck Pond limestone is overlain unconformably by slate of the Seboomook formation on the east. At outcrop 10 the contact is irregular in form. The slate occurs in thin layers up to 6 inches thick on the surface of the limestone, which is more or less parallel to the general trend of the slate-limestone contact at this point. Some of the slate occurs as thinner layers about 2 inches thick that extend down into cavities in the limestone. At outcrop 11 the contact is also irregular. The rock consists of large, rounded, sub-angular granite boulders (up to 8 feet in maximum dimensions) in a limestone conglomerate matrix. Many of the granite boulders extend up into the slate at least several feet. Several of the large boulders have a thin veneer of slate a few millimeters thick, and within a foot of the larger granite boulders the slate in many places tends to cleave into curved slabs.

At outcrop 12, Member 4 consists of large, sub-angular granite boulders at least 10 to 15 feet across in a limestone conglomerate matrix. The limestone conglomerate is exposed only at one point on the west side of the outcrop, where it lies between two granite boulders and is less than one foot thick. On the east side of the outcrop the exposed portions of the boulders are surrounded by slate. The boulders protrude at least 6 feet up into the slate, and several of the boulders have a thin veneer of slate. The large boulders protruding up into the slate make the contact very irregular at this point.

At outcrop 15 a sub-angular granite boulder at least 7 feet across protrudes up into the slate. A few feet to the east, several smaller boulders about 4 inches across in a limestone conglomerate matrix are overlain by a thin veneer of slate.

In the upper part of outcrop 16 limestone conglomerate with a few sub-angular to sub-rounded granite boulders at least 1 to 2 feet thick is overlain unconformably by an irregular veneer of slate a few inches thick. The limestone conglomerate has well-defined bedding (strike N. 10° - 30° E.; dip 45° S.) and some cross-bedding. In the lower part of the outcrop about 5 feet of slate extend eastward from the contact. Bedding in the slate here strikes N. 10° E. and dips 40° E. In some parts of the outcrop near the contact the slate spalls off in curved slabs. In places it has slickensided surfaces which are very localized and show no pattern of orientation.

At outcrop 19 the slate of the Seboomook formation is underlain by sandy limestone conglomerate with angular to sub-angular granite boulders up to 8 inches thick. Some of the granite boulders protrude up into the slate, which occurs as a thin veneer (up to a few inches thick) on the surface of the conglomerate. The outcrop surface is oriented roughly parallel to the contact, which strikes about N. - S. and dips about 50° E. The contact is very irregular.

At outcrop 20 the contact is also very irregular, its general orientation being N. - S. and 50° E. The slate occurs as a layer up to several inches thick on the limestone.

As shown on the map, the contact between the slate of the Seeboomook formation and the Beck Pond limestone has a general trend of N. 15° W. between outcrop 10 and outcrop 20. At three different localities the contact has the following general trends: N. 17° W., 30° E. at outcrop 10; N. 15° E., 40° E. at outcrop 16; and N. - S., 50° E. at outcrop 20. At outcrop 20 the contact apparently bends sharply to the west, continuing westward about 700 feet to outcrop 41. It has a general strike of N. - S. along the granite talus ridge from outcrop 41 to outcrop 39. The granite talus ridge is only about 40 to 50 feet above outcrop 20, so this bend in the contact is not caused by relief. The slate may originally have been deposited on an irregularly shaped surface, or the contact may later have been folded. However, there is no evidence for folding other than the bend itself. It is possible that the bend is a fault cutting across the region, but there is no evidence for such a fault.

The granite, the Beck Pond limestone, and the Seboomook formation are all cut by diabase. In the northern part of the area the granite is in contact with a large body of diabase, but the contact is not exposed. In the central part of the area the granite is also cut by diabase, and the contact is exposed in one place along the granite talus ridge, about 300 feet north of the south end of outcrop 41. There the contact strikes about N. - S. and dips 70° E. The granite and diabase occur side by side, with a 4-inch gap between them. On either side of the gap the surfaces of the granite and diabase are more or less planar and show no slickensiding or other evidence of faulting. No contact metamorphism is seen in the granite. There is no variation in the grain size of the diabase or the granite. Owing to the quantity of large angular residual talus on the contact, the actual contact surface was not seen. The contact between the diabase and the Beck Pond limestone is exposed at two localities about 10 feet east of outcrop 18. At the outcrop near the north tip of outcrop 18 the contact has a general trend of N. 40° - 50° W. and 40° E. but is very irregular. The diabase is phaneritic away from the contact but becomes very fine grained near the contact, the change in grain size being gradual rather than abrupt. The limestone at the contact has the appearance of being very weathered. It is exposed through small openings about 1 to 2 feet in diameter in a layer of diabase. At the outcrop near the south tip of outcrop 18 the contact is irregular but has a general trend of N. - S. and 20° - 25° E. The diabase becomes fine grained at the contact. At outcrop 37 the contact between the diabase and the Seboomook formation is horizontal, with the diabase on top. The diabase is phaneritic and becomes finer grained toward the contact, but there is no apparent change in the slate. The contact is sharp and well-defined.

In the northern part of the area the diabase occurs as a large body. In the southern and central parts of the area the diabase is mapped as a second body, but it may be a number of separate small bodies. The diabase at outcrop 37 is mapped as a separate body, but again it may be a number of bodies.

At outcrop 45 lime-silicate hornfels is in contact with the diabase. The hornfels is apparently surrounded by diabase and is very possibly a xenolith.

Slickensided joints occur in many of the diabase and limestone outcrops. The amount of movement could not be determined on any of them, but it was probably small.

Depositional History

The Beck Pond area is situated on the northwest limb of the Moose River synclinorium, where it straddles the boundary between southeast-dipping Siluro-Devonian strata and a nonconformably underlying basement complex chiefly of granitic and gneissic rocks. The regional strike and dip of the Siluro-Devonian strata is about N. 30° E. and 30° S. on this limb of the Moose River synclinorium, and the bedding attitudes measured for the Beck Pond limestone are in general accord with this. In the Beck Bond area the embayment of the Seboomook formation to the northwest diverges from the regional strike. This local divergence can be explained only as a primary feature reflecting an original irregularity in bottom topography.

The Seboomook formation seems to be a partly contemporaneous and partly younger fine- to medium-grained unit which first filled adjacent depressions in the bottom topography and ultimately covered both the Beck Pond limestone and the adjacent basement complex. The Bear Pond limestone member, consisting of calcareous and granitic debris similar to that of the Beck Pond limestone, may have been a small mass of consolidated shell debris which slumped into the slate of the Seboomook from a topographically higher area. Lack of evidence for soft rock deformation in the slate of the Seboomook formation underlying the Bear Pond limestone member suggests that the slate was at least partly consolidated before the limestone was deposited. The existence of well-developed bottom topography on and adjacent to the basement complex in this area would be consistent with the geologic history postulated by Boucot for strata of Late Silurian and Early Devonian age elsewhere in the region.

The Beck Pond limestone is most easily interpreted as having been deposited on a topographic high in shallow water suitable for biostromal growth, which intermittently had available to it medium-grained to coarse clastic debris derived from a still higher, adjacent area of basement complex. The two southern members (4 and 5) are stratigraphically highest and contain a large amount of coarse granite debris, whereas the three northern members (1, 2, and 3) contain little coarse-grained granitic debris.

Member 1, the lowest, contains much quartz sand and a few granite pebbles in a limy matrix. The quartz sand and granite pebbles were presumably derived from the adjacent basement complex, which probably was present as part of a large island. During the deposition of Member 2, little material derived from the adjacent basement complex was incorporated into the sediment. Member 2 is characterized by the development of abundant stromatoporoid biostromes. During the deposition of Member 3, granite debris in sand and pebble sizes was again incorporated into the sediment. The relative absence of granitic debris in Member 2 can be explained in a number of ways, but a temporary change in either local topography or current distribution patterns seems reasonable.

The influx of granite boulders and coarse granite debris during the deposition of Member 4 is puzzling. Most of the granite debris is sub-rounded and poorly sorted. The granitic fragments in Member 4 resemble the granitic base-

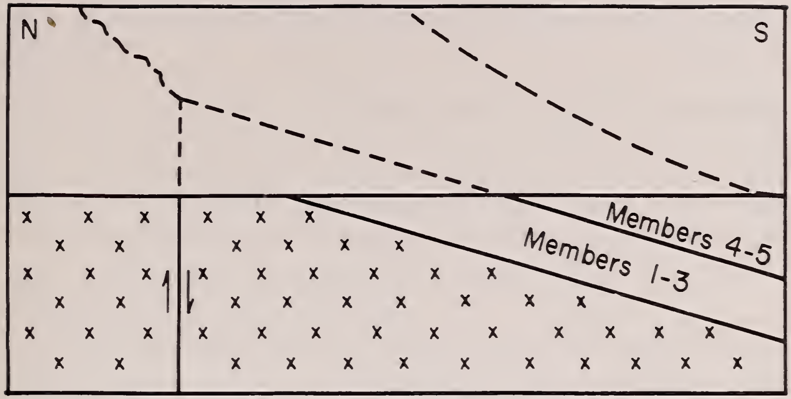

Figure 4. Cross-section illustrating possibility that a northern fault of post-Member 3 and pre-Member 4 age could have created relief adequate to supply granite boulders and cobbles to Members 4 and 5.

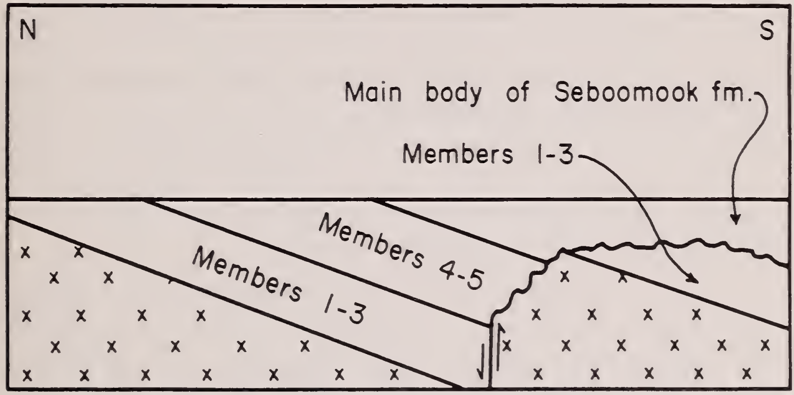

Figure 5. Cross-section illustrating possibility that a southerly fault of post-Member 3 and pre-Member 4 age could have created relief adequate to supply granite boulders and cobbles to Members 4 and 5.

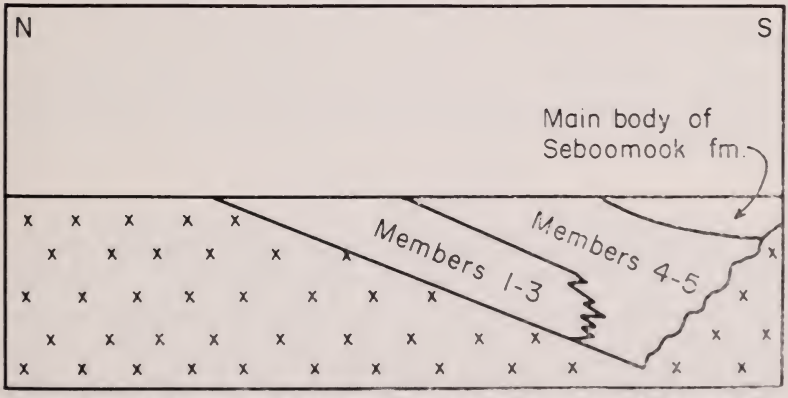

Figure 6. Cross-section illustrating possibility that Members 1, 2, and 3, are at least partly facies of Members 4 and 5, and that the granite boulders and cobbles of Members 4 and 5 were derived from a pre-existing knob of basement complex whose top is now buried beneath slate of the Seboomook formation.

ment complex to the north, which is the nearest known area of basement complex. If these boulders were transported from the north, it would be necessary to postulate the rapid development of local relief sufficient to provide large boulders after the deposition of Member 3. Such relief could have been provided by a fault, though no field evidence for one was found. Subsequent folding and erosion (fig. 4) could then explain the present distribution of the five members.

A second alternative is to assume that subsequent to the deposition of Member 3 and prior to the deposition of Member 4 a fault came into existence immediately to the south of the Beck Pond limestone exposures (fig. 5). Such a fault could have created sufficient local relief to have shed granitic debris to the north. However, the problem of getting rid of this high area of granite in an area now occupied by slate of the Seboomook formation makes necessary either rapid erosion of the granite if it were immediately adjacent to the area now occupied by Member 4, or transportation of the coarse debris from a greater distance to the southeast. The pre-Silurian beds about four miles to the southeast are chiefly slates, thus setting an upper limit for the distance over which transportation could have occurred.

A third alternative is to consider Members 4 and 5 as lateral facies of Members 1, 2, and 3, the former being derived from pre-existing granite knobs (fig. 6) to the southeast which were subsequently buried under the slate of the Seboomook formation.

It is unlikely that the granitic debris could have been derived from the east or west of the Beck Pond area, as hills in both directions are capped by igneous rocks markedly different from the granitic fragments in the Beck Pond limestone.

Sampling Procedure

The sampling of the limestone was done by taking random samples in the form of small rock chips, about ¾ of an inch across, from the outcrop faces. Care was taken to avoid sampling along the strike of the limestone bedding. The average length of outcrop sampled per sample bag was about 50 to 60 feet, which in most places represented 25 to 30 feet of section. Each bag was full and weighed about 1 to 1½ pounds.

In the preparation of the samples, the crushing, grinding, and quartering machines were cleaned before each sample was run through them. Then each sample was crushed to fragments no larger than a quarter of an inch. The fragmented samples were poured into a quartering device, and half of each sample was further ground into a fine powder and placed in a small glass jar.

Approximately one to two grams of each of the powdered samples were placed in 100-milliliter glass beakers which previously had been weighed empty. The beaker plus the sample were then weighed, and the sample weight was calculated by subtracting the empty-beaker weight from the sample-plus-beaker weight. After the analysis, the beaker-plus-residue weight was determined, and from it was subtracted the empty-beaker weight to give the weight of the residue. Residue percentages were calculated from the sample and residue weights.

All weighing was done on a Chainomatic analytical balance to the nearest 1/10 of a milligram. Every sample was weighed against one tare, which was weighed (empty) four times:

1) before weighing empty beakers and samples
2) after ” ” ” ” ”
3) before ” the beakers plus residues
4) after ” ” ” ” ”

All of the tare weighings checked to within 0.0006 grams or less than one (1) percent of the weight of the lightest residue.

For determination of the amount of insoluble matter, dilute hydrochloric acid (approximately 6N) was added to the samples, slowly at first to prevent too violent effervescence which might have thrown some of the sample out of the beaker. The first four samples were heated gently and stirred during the application of heat, but no further effervescence occurred so heat was not applied to the remainder of the samples. The first four were then decanted and more acid was poured into the beaker. Again no effervescence occurred for any of the four, so the procedure was not repeated. More than enough of the acid was added to each sample and all effervescence was allowed to cease completely, however, before the solution was decanted. After allowing sufficient time for the residue to settle, most of the liquid was carefully decanted. The residue was washed and thoroughly agitated with distilled water. This process was repeated until the decanted solutions gave only a trace of AgCl precipitate when one or two drops of $AgNO_3$ were added. Two thorough washings were usually sufficient to remove most of the Cl-ion from the beaker. After the final wash was decanted, the residues were dried in a drying oven for about half an hour and reweighed.

Nine of the samples were run twice (as completely separate samples), and one of the nine was run three times to check the precision of the analysis. The results are shown in Table 1.

TABLE 1. WEIGHT PERCENT OF INSOLUBLES IN THE BECK POND LIMESTONE

Stratigraphic unit	Sample number	Weight % of insolubles			Outcrop number and approximate position in outcrop
		Run 1	Run 2	Run 3	
Member 5	1	42.9			10 (north half)
Member 5	2	27.6	29.2		10 (south half)
Member 5	3	24.0	26.0		9 (northeast end)
Member 5	4	34.7	39.1		9 (center)
Member 5	5	30.1	30.9		9 (west end)
Member 5	6	25.8			8
Member 5	7	44.3			7
Member 5	8	24.9			3 and 4
Member 5	9	48.2			2 (east end)
Member 5	10	47.9			2 (east center)
Member 5	11	29.2	29.5		2 (west center)
Member 5	12	41.0			2 (west end)
Member 3	13	78.7			18 (center and south end)
Member 3	14	61.3			18 (sandy lenses only)
Member 3	22	32.7			22 (southern 50 to 60 feet)
Member 2	15	17.9			18 (north end)
Member 2	16	15.7			23
Member 2	21	21.6			24–27
Member 2	23	6.0	6.1		22 { Each sample represents about 50 to 60 feet along outcrop, from south (sample 23) to north (sample 27) and excluding southernmost 50 to 60 feet.
Member 2	24	6.8			
Member 2	25	13.2			
Member 2	26	6.9			
Member 2	27	7.8			
Member 1	17	13.7	13.5	14.4	33 (south end and center)
Member 1	18	24.3			28 (north end)
Member 1	19	39.2			28 (center)
Member 1	20	32.2			28 (south end)
Member 1	28	21.2	21.1		32

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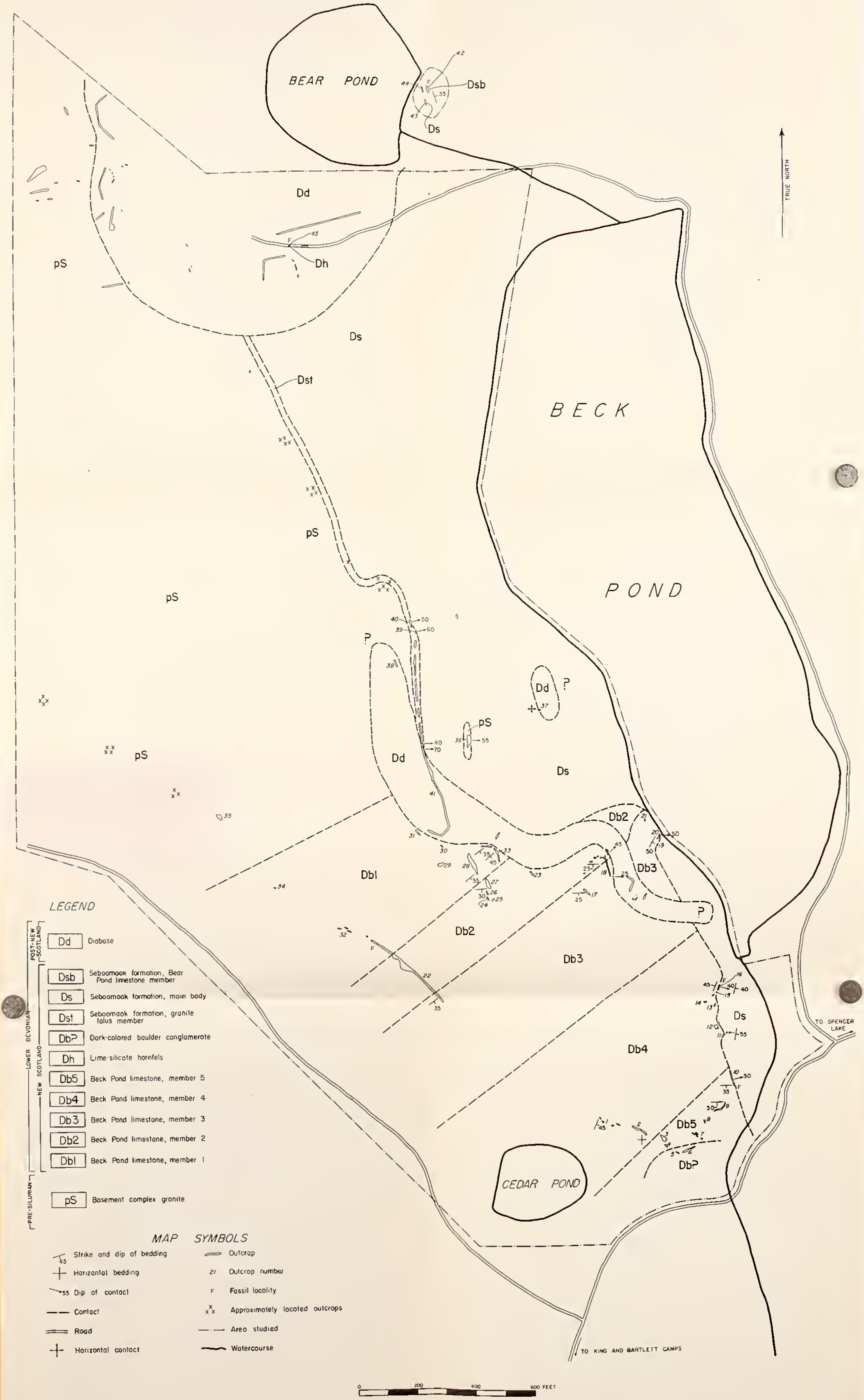
BEAR POND
Dsb
Ds
Dd
Dh
F
pS
Ds
Dst
pS
pS
pS
BECK
POND
?
Dd
?
pS
Dd
Ds
Db2
Db3
Dbl
Db2
Db3
?
Ds
Db4
Db5
Db?
CEDAR POND
TRUE NORTH
TO SPENCER LAKE
TO KING AND BARTLETT CAMPS
LEGEND
POST-NEW SCOTLAND
LOWER DEVONIAN
NEW SCOTLAND
PRE-SILURIAN
Dd Diabase
Dsb Seboomook formation, Bear Pond limestone member
Ds Seboomook formation, main body
Dst Seboomook formation, granite talus member
Db? Dark-colored boulder conglomerate
Dh Lime-silicate hornfels
Db5 Beck Pond limestone, member 5
Db4 Beck Pond limestone, member 4
Db3 Beck Pond limestone, member 3
Db2 Beck Pond limestone, member 2
Dbl Beck Pond limestone, member 1
pS Basement complex granite
MAP SYMBOLS
45 Strike and dip of bedding
Horizontal bedding
55 Dip of contact
Contact
Road
Horizontal contact
Outcrop
21 Outcrop number
F Fossil locality
x x x Approximately located outcrops
Area studied
Watercourse
0
200
400
600 FEET

GEOLOGY OF THE BECK POND AREA

Geology by Charles Harper and Keith Rhea, 1958